

HEART DISEASE IN PREGNANCY 4

Ischemic Heart Disease and Cardiomyopathy in Pregnancy

Gregory A.L. Davies, MD, FRCSC, FACOG,¹ William N.P. Herbert, MD, FACOG²¹Professor and Chair, Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynaecology, Queen's University, Kingston ON²William Norman Thornton Professor and Chair, Department of Obstetrics and Gynecology, University of Virginia, Charlottesville VA**Abstract**

Ischemic heart disease and cardiomyopathy in pregnancy are both rare. Therefore, a high level of suspicion is required by the obstetric caregiver when women complain of the often vague symptoms that are indicative of these conditions. Early diagnosis, consultation with a cardiologist, and aggressive therapy are the keys to reducing morbidity and mortality. Women who suffer myocardial infarction in pregnancy should be stabilized, and delivery within the first two weeks post event should be avoided if possible. Women who completely recover from peripartum cardiomyopathy can be reassured when considering future pregnancies. Pregnancy should be considered contraindicated in women with Class H diabetes, and efforts should be made to establish reliable contraception.

This is the fourth in a series of five articles reviewing in detail the assessment and management of specific cardiac disorders in pregnancy.

Résumé

La cardiopathie ischémique et la cardiomyopathie au cours de la grossesse sont toutes deux rares. Ainsi, le fournisseur de soins obstétricaux se doit de faire preuve d'un degré élevé de méfiance lorsqu'une patiente se plaint des symptômes souvent vagues qui sont associés à ces pathologies. L'établissement d'un diagnostic précoce, la consultation avec un cardiologue et la mise en œuvre d'un traitement agressif sont les clés de la diminution de la morbidité et de la mortalité. Les femmes qui présentent un infarctus du myocarde au cours de la grossesse devraient faire l'objet d'une stabilisation; de plus, dans la mesure du possible, l'accouchement devrait être évité au cours des deux semaines suivant l'incident. Les femmes qui se remettent entièrement d'une cardiomyopathie péripartum peuvent être rassurées en ce qui a trait aux futures grossesses. La grossesse devrait être considérée comme étant contre-indiquée pour les femmes qui présentent un diabète de classe H; dans un tel cas, des efforts devraient

également être déployés en vue de la mise en œuvre d'une contraception fiable.

Il s'agit du quatrième article d'une série de cinq analysant en détail l'évaluation et la prise en charge de troubles cardiaques particuliers au cours de la grossesse.

J Obstet Gynaecol Can 2007;29(7):575-579

Coronary Artery Disease

Coronary ischemia or myocardial infarction are rare during pregnancy.¹⁻¹¹ The prevalence of ischemic heart disease in pregnancy is reported at 1 in 10 000 deliveries.¹² The incidence of myocardial infarction in pregnancy is estimated to be 7.5 in 100 000 deliveries. However, there were no myocardial infarctions reported in one series of 226 383 pregnancies from Ireland.^{10,13} Hankins et al. presented two cases and reviewed 68 others from the literature and found an overall mortality rate of 37% from myocardial infarction in pregnancy.⁹ Mortality was highest in women under 35 years of age (43%), who were in the third trimester (45%), and who delivered within two weeks of infarction (50%). Surprisingly, only 13% of women in this series were known to have underlying coronary artery disease before pregnancy. This finding emphasizes the point that a high level of suspicion must be maintained when pregnant women present with signs and symptoms compatible with myocardial ischemia or infarction. Of the 68 women who had a myocardial infarction, fetal loss was reported in 34%.⁹ Risk factors for the pregnant population include smoking, diabetes, a family history of myocardial infarction before age 60, a lipid abnormality, and a history of chronic hypertension.^{14,15} Patients with congenital heart disease, specifically uncorrected anomalous origins of the coronary arteries or severe aortic stenosis, are at increased risk.¹⁶ Other causes of myo-

Key Words: Pregnancy, heart disease, ischemia, cardiomyopathy, myocardial infarction, coronary artery disease

Competing Interests: None declared.

Received on December 7, 2006

Accepted on April 16, 2007

cardial infarction in pregnancy include Kawasaki disease, hypertrophic cardiomyopathy, spontaneous coronary artery dissection, and metastatic carcinoma.^{17–22}

Making a diagnosis of myocardial infarction in pregnant patients is essentially the same as in non-pregnant patients, keeping in mind that the ECG in normal pregnancy may show left-axis deviation and non-specific ST and T wave changes. Also, the chest X-ray in normal pregnancy may show enlargement of the heart, straightening of the left heart border, and increased vascular markings.¹⁶ CK-MB levels associated with myocardial infarction in pregnancy correlate with those in infarcting non-pregnant patients but may be influenced by placental and uterine stores when tested at the time of labour and delivery.^{10,23} The troponin I level in serum appears to be the marker of choice of myocardial injury in the pregnant patient because levels are not altered by normal pregnancy and delivery or influenced by obstetric anaesthesia.²³

Management of myocardial infarction in pregnant patients is similar to that in non-pregnant patients and includes administration of oxygen, nitrates, morphine, lidocaine and most other antiarrhythmics, calcium channel blockers, β -blockers, heparin, low-dose aspirin, and invasive hemodynamic monitoring if necessary. The use of angioplasty and systemic and local thrombolytic therapy has been described in case reports, with successful outcomes.^{24–28}

Myocardial infarction is not an indication for immediate delivery. In fact, mortality is higher in patients who deliver within two weeks of myocardial infarction. When labour ensues, Caesarean section should be reserved for obstetrical indications, because it does not protect patients from the dramatic changes in stroke volume and cardiac output associated with the immediate postpartum period.²⁹ Electrocardiographic monitoring in labour is recommended.

Cardiac Surgery and Cardiopulmonary Bypass Surgery

Most patients with severe cardiac disease in pregnancy can be managed medically. However, surgical correction using interventional or open techniques will occasionally be required. Successful angioplasty with or without stenting and thrombolysis has been reported.^{26–28,30,31} In order to reduce fetal radiation exposure from fluoroscopy, some have suggested guidance by means of transesophageal echocardiography. Maternal and fetal mortality rates with interventional procedures are low.

Pregnancy appears to increase the mortality risk associated with cardiac surgery. In their review, Weiss et al. reported an overall maternal mortality of 6%. For those with valve disease the mortality was 9%, increasing to 22% for those with aortic or arterial dissection repairs and pulmonary

embolectomies.³² If circumstances permit, cardiac surgery and cardiopulmonary bypass should take place in the second trimester, thereby avoiding drug exposures during the first trimester and the increased risk of premature labour in the third trimester. If the fetus is mature, consideration should be given to delivery at the time of cardiac surgery. The fetal loss rate associated with cardiopulmonary bypass is 20% to 40%.^{33,34} Recent experience with maternal hypothermia (35°C) and pulsatile perfusion appears to offer an improved fetal outcome.^{35–37}

Pregnancy Following Cardiac Transplantation

Several cases of successful pregnancy in patients who have undergone cardiac transplantation have been reported, although there are insufficient data to fully define the risks for mother and infant.^{38–41} Patients who have undergone cardiac transplantation do not have the normal afferent innervation of the graft,⁴² although some late reinnervation may occur. Therefore, it is important to realize that these patients might not experience the common symptom of chest pain associated with cardiac ischemia or infarction. Cardiac grafts do have the ability to respond normally by means of the Starling mechanism to the increase in stroke volume seen in pregnancy.⁴³

By nature of having undergone transplantation, these patients are at risk for acute or chronic organ rejection. The incidence of organ rejection in pregnancy is unknown for cardiac transplant patients. In women with renal transplantation who undergo pregnancy, the rate of organ rejection is no higher than in non-pregnant allograft recipients.

Immunosuppressive therapy is required for transplantation patients during pregnancy.⁴⁴ Prednisone and its metabolite, prednisolone, appear to be safe to use after the first trimester, but exposure in the first trimester may increase the risk of orofacial clefts.⁴⁵ Cyclosporine and azathioprine cross the placenta,^{46,47} but no embryo-lethal or teratogenic effects have been identified from these substances.⁴⁵ Because few patients have received these medications in pregnancy, the full effects on the fetus remain uncertain.

Peripartum Cardiomyopathy

Peripartum cardiomyopathy was first described in the 1930s.^{48–50} The incidence has been quoted as 1 in 3000 to 4000 deliveries,^{49–52} although some believe it to be much less common.⁵³ In 1971, Demakis and Rahimtoola described women who developed cardiomyopathy in the month preceding delivery. The criteria used for the diagnosis of peripartum cardiomyopathy were the development of cardiac failure in the last month of pregnancy or within five months postpartum, the lack of another cause for the patient's cardiac failure, and the lack of cardiac disease preceding the month before delivery.⁵⁴ In their 20-year

experience with peripartum cardiomyopathy, Demakis et al. found that patients at higher risk for peripartum cardiomyopathy included older, multiparous patients and those with preeclampsia or twins.⁵⁵ Eighty-one percent of women with peripartum cardiomyopathy developed signs or symptoms, usually including shortness of breath, lung field crackles, and edema, within the first three postpartum months.

The presence of cardiomegaly at six months after initial presentation was a significant predictor of a patient's risk of mortality and morbidity from cardiac disease. Demakis et al. described two groups; in the first, 14 patients had normal heart size at six months after initial presentation and were followed for a mean of 10.7 years.⁵⁵ Two of these 14 patients died of non-cardiac causes, and the remainder were either asymptomatic or had only mild exertional symptoms. Of the 12 survivors, eight had 21 subsequent pregnancies without any deterioration in their cardiac status. The second group consisted of 13 patients who had persistent cardiomegaly at six months after initial presentation. This group had a much higher likelihood of persistent cardiac disease. Eleven patients (85%) died of congestive heart failure with a mean survival time of 4.7 years. Within this group, six patients had subsequent pregnancies, and three of these patients deteriorated during the puerperium.⁵⁵

Another review of 329 patients with peripartum cardiomyopathy revealed that 3.5% developed symptoms in the eight-week period before delivery.⁵⁶ Of the patients developing symptoms postpartum, 37% were within one month of delivery and another 60% were in the second month. Only 4.3% of patients developed symptoms more than six months postpartum.⁵⁶

Although several etiological factors have been suggested, no specific cause for peripartum cardiomyopathy has been identified.^{49,51,54,55,57-63} The population of women who develop peripartum cardiomyopathy probably includes women with unrecognized pre-existing dilated cardiomyopathy and women with acute viral myocarditis during pregnancy. Cardiac biopsy results have been non-specific and have shown myocardial fibre degeneration, interstitial edema, and occasionally lymphocytic infiltration.^{49,51,54,62,64} For patients in whom endomyocardial biopsy has shown inflammatory myocarditis, immunosuppression has been reported to be successful in some.^{59,65} Endomyocardial biopsy is not required in all patients but has been suggested for those who do not respond to standard medical therapy.⁶⁶

More common causes for congestive heart failure in the puerperium include iatrogenic fluid therapy overload, tocolytic therapy with β -sympathomimetics or magnesium sulphate, anemia, or previously undiagnosed congenital

heart disease. These possibilities should be eliminated before the diagnosis of peripartum cardiomyopathy is made.

The investigation of a patient suspected of having peripartum cardiomyopathy should include a complete blood count, electrocardiogram, chest X-ray, arterial blood gases, and an echocardiogram.

Treatment for peripartum cardiomyopathy, other than limiting physical activity, depends on the patient's symptomatology and is generally similar to the treatment of dilated cardiomyopathy. This may include reducing preload and afterload and maximizing ventricular contractility. Reduction in preload can be accomplished by restricting salt intake and by the use of diuretics such as furosemide. Afterload reduction can be accomplished using hydralazine. Angiotensin-converting enzyme inhibitors have been suggested for the reduction of afterload in patients with peripartum cardiomyopathy,^{49,67} and they may be used safely in the postpartum patient. Angiotensin-converting enzyme inhibitors should be used with caution during pregnancy because they have been associated with stillbirth and severe renal toxicity of the fetus.⁴⁵ Cardiac function can usually be improved by treating underlying anemia and by using digoxin. Prophylactic anticoagulation has been suggested for patients while dilatation of the heart persists.⁶⁷ For patients in whom full medical therapy is not successful, the possibility of cardiac transplant should be entertained.

Although some authors recommend that pregnancy in the future should be avoided in patients affected with peripartum cardiomyopathy,⁶⁷ others suggest that if the patient has recovered fully and has normal ventricular function, future pregnancies may be considered.^{49,66} These patients should be followed closely in any future pregnancy. Recurrence of peripartum cardiomyopathy has been estimated at 0% to 26%.^{49,55,68}

Class H Diabetes

In 1949, White described a classification of diabetes in pregnancy based on age of onset, duration, and complications that is still widely used today.⁶⁹ Class H diabetics are those who have ischemic cardiac disease, regardless of the duration of diabetes. There have been several case reports of diabetic women who have had cardiac ischemia or infarction and subsequently had successful pregnancies.⁷⁰ However, a maternal mortality rate as high as 66% to 75% in these women has been described.⁷¹ Given the limited reported experience with class H diabetes in pregnancy, each patient should be evaluated individually and counselled concerning the significant potential for life-threatening complications. Many obstetricians consider class H

diabetes to be one of the few diabetic contraindications to pregnancy.

REFERENCES

- Shalev Y, Ben-Hur H, Hagay Z, Blickstein I, Epstein M, Ayzenberg O, et al. Successful delivery following myocardial ischemia during the second trimester of pregnancy. *Clin Cardiol* 1993;16:754–6.
- Frenkel Y, Baraki G, Resin L, Rath S, Mashiach S, Battler A. Pregnancy after myocardial infarction: are we playing safe? *Obstet Gynecol* 1991;77:822–5.
- Taylor GW, Moliterno DJ, Hillis LD. Peripartum myocardial infarction. *Am Heart J* 1993;126:1462–3.
- Allen JN, Wewers MD. Acute myocardial infarction with cardiogenic shock during pregnancy: treatment with intra-aortic balloon counterpulsation. *Crit Care Med* 1990;18:888–9.
- Sheikh AU, Harper MA. Myocardial infarction during pregnancy: management and outcome of two pregnancies. *Am J Obstet Gynecol* 1993;169:279–84.
- Liu SS, Forrester RM, Murphy GS, Chen K, Glassenberg R. Anaesthetic management of a parturient with myocardial infarction related to cocaine use. *Can J Anaesth* 1992;39:858–61.
- Nolan TE, Savage RW. Peripartum myocardial infarction from presumed Kawasaki's disease. *South Med J* 1990;83:1360–1.
- Aglio LS, Johnson MD. Anaesthetic management of myocardial infarction in a parturient. *Br J Anaesth* 1990;65:258–61.
- Hankins GDV, Wendel GD Jr, Leveno KJ, Stoneham J. Myocardial infarction during pregnancy: a review. *Obstet Gynecol* 1985;65:139–46.
- Donnelly S, McKenna P, McGing P, Sugrue D. Myocardial infarction during pregnancy. *Br J Obstet Gynaecol* 1993;100:781–2.
- Frenkel Y, Etchin A, Barkai G, Reisin L, Mashiach S, Battler A. Myocardial infarction during pregnancy: a case report. *Cardiology* 1991;78:363–8.
- Ginz B. Myocardial infarction in pregnancy. *J Obstet Gynaecol Br Commonw* 1970; 77:610–5.
- Fletcher E, Knox EW, Morton P. Acute myocardial infarction in pregnancy. *Br Med J* 1967;3:586–8.
- Rosenberg L, Shapiro S, Kaufman DW, Slone D, Miettinen OS, Stolley PD. Cigarette smoking in relation to the risk of myocardial infarction in young women. Modifying influence of age and predisposing factors. *Int J Epidemiol* 1980;9:57–63.
- Pyeritz RE. Genetics and cardiovascular disease. In: Braunwald E, ed. *Heart disease: a textbook of cardiovascular medicine*. Philadelphia: WB Saunders, 1992:1622.
- Nolan TE, Hankins GDV. Myocardial infarction in pregnancy. *Clin Obstet Gynecol* 1989;32:68–75.
- Willerson JT. Acute myocardial infarction. In: Wyngaarden JB, Smith LS, eds. *Cecil's textbook of medicine*. Philadelphia: WB Saunders, 1985:289–96.
- Factor SM, Bache RJ. Pathophysiology of myocardial ischemia. In: Schlant RC, Alexander RW, O'Rourke RA, eds. *Hurst's the heart*. New York: McGraw-Hill, 1994:1033.
- Vicari R, Eybel C, Monson D. Survival following spontaneous coronary artery dissection: surgical repair by extrusion of intramural hematoma. *Am Heart J* 1986;3:593–7.
- Shaver PJ, Carrig TF, Baker WP. Postpartum coronary artery dissection. *Br Heart J* 1978;40:83–6.
- Akaike A, Ito T, Sada T, Kamyar R, Koro T, Matsumoto S, et al. Myocardial infarction due to metastasis of choriocarcinoma in a 29-year-old woman. *Jpn Circ J* 1977;41:1257–63.
- Esinler I, Yigit N, Ayhan A, Kes S, Aytemir K, Acil T. Coronary artery dissection during pregnancy. *Acta Obstet Gynecol Scand* 2003;82:194–6.
- Shade GH Jr, Ross G, Bever FN, Uddin Z, Devireddy L, Gardin JM. Troponin I in the diagnosis of acute myocardial infarction in pregnancy, labor, and post partum. *Am J Obstet Gynecol* 2002;187:1719–20.
- Ascarelli MH, Grider AR, Hsu HW. Acute myocardial infarction during pregnancy managed with immediate percutaneous transluminal coronary angioplasty. *Obstet Gynecol* 1996;88:655–7.
- Eickman FM. Acute coronary artery angioplasty during pregnancy. *Cathet Cardiovasc Diagn* 1996;38:369–72.
- Webber MD, Halligan RE, Schumacher JA. Acute infarction, intracoronary thrombolysis, and primary PTCA in pregnancy. *Cathet Cardiovasc Diagn* 1997;42:38–43.
- Sharma GL, Loubeyre C, Morice MC. Safety and feasibility of the radial approach for primary angioplasty in acute myocardial infarction during pregnancy. *J Invasive Cardiol* 2002;14:359–62.
- Sullebarger JT, Fontanet HL, Matar FA, Singh SS. Percutaneous coronary intervention for myocardial infarction during pregnancy: a new trend? *Invasive Cardiol* 2003;15:725–8.
- James CF, Banner T, Caton D. Cardiac output in women undergoing cesarean section with epidural or general anesthesia. *Am J Obstet Gynecol* 1989;160:1178–84.
- Craig S, Ilton M. Treatment of acute myocardial infarction in pregnancy with coronary artery balloon angioplasty and stenting. *Aust N Z J Obstet Gynaecol* 1999;39:194–6.
- Wang YM, Mak GY, Lai KN, Lui SF. Treatment of Takayasu's aortitis with percutaneous transluminal angioplasty and wall stent—a case report. *Angiology* 1998;49:945–9.
- Weiss BM, von Segesser LK, Alon E, Seifert B, Turina MI. Outcome of cardiovascular surgery and pregnancy: a systematic review of the period 1984–1996. *Am J Obstet Gynecol* 1998;179:1643–53.
- Bernal JM, Miralles PJ. Cardiac surgery with cardiopulmonary bypass during pregnancy. *Obstet Gynecol Surv* 1986;41:1–6.
- Salazar E, Espinola N, Molina FJ, Reyes A, Barragan R. Heart surgery with cardiopulmonary bypass in pregnant women. *Arch Cardiol Mex* 2001;71:20–7.
- Tripp HF, Stiegel RM, Coyle JP. The use of pulsatile perfusion during aortic valve replacement in pregnancy. *Ann Thorac Surg* 1999;67:1169–71.
- Jahangiri M, Clark J, Prefumo F, Pumphrey C, Ward D. Cardiac surgery during pregnancy: pulsatile or nonpulsatile perfusion? *Ann Thorac Cardiovasc Surg* 2003;126:894–5.
- Mahli A, Izdes S, Coskun D. Cardiac operations during pregnancy: review of factors influencing fetal outcome. *Ann Thorac Surg* 2000;69:1622–6.
- Carvalho AC, Almeida D, Cohen M, Lima V, Moura L, Buffolo E, et al. Successful pregnancy, delivery and puerperium in a heart transplant patient with previous peripartum cardiomyopathy. *Eur Heart J* 1992;13:1589–91.
- Liljestrand J, Lindstrom B. Childbirth after postpartum cardiac insufficiency treated with cardiac transplant. *Acta Obstet Gynecol Scand* 1993;72:406–8.
- Baxi LV, Rho RB. Pregnancy after cardiac transplantation. *Am J Obstet Gynecol* 1993;169:33–4.
- Key TC, Resnik R, Dittrich HC, Reisner LS. Successful pregnancy after cardiac transplantation. *Am J Obstet Gynecol* 1989;160:367–71.
- Schroeder JS, Hunt SA. Cardiac transplantation: where are we? *N Engl J Med* 1986;315:961–3.
- Guzman CA, Caplan R. Cardiorespiratory response to exercise during pregnancy. *Am J Obstet Gynecol* 1970;108:600–5.
- Kossov LR, Herbert CM III, Wentz AC. Management of heart transplant recipients: guidelines for the obstetrician–gynecologist. *Am J Obstet Gynecol* 1988;159:490–9.

45. Briggs GG, Freeman RK, Yaffe SJ. *Drugs in pregnancy and lactation*. 6th ed. Baltimore: Williams & Wilkins; 2002.
46. Flechner SM, Katz AR, Rogers AJ, Van Buren C, Kahan BD. The presence of cyclosporine in body tissues and fluids during pregnancy. *Am J Kidney Dis* 1985;5:60-3.
47. Saarikoski S, Seppala M. Immunosuppression during pregnancy: transmission of azathioprine and its metabolites from the mother to the fetus. *Am J Obstet Gynecol* 1973;115:1100-6.
48. Gouley BA, McMillan TM, Bellet S. Idiopathic myocardial degeneration associated with pregnancy and especially the puerperium. *Am J Med Sci* 1937;194: 185-99.
49. Lee W. Clinical management of gravid women with peripartum cardiomyopathy. *Obstet Gynecol Clin North Am* 1991;18:257-71.
50. Hull E, Hidden E. Postpartal heart failure. *South Med J* 1938;31:265-70.
51. Meadows WR. Idiopathic myocardial failure in the last trimester of pregnancy and the puerperium. *Circulation* 1957;15:903-14.
52. Meadows WR. Postpartum heart disease. *Am J Cardiol* 1960;6:788-802.
53. Cunningham FG, Pritchard JA, Hankins GDV, Anderson PL, Lucas MJ, Armstrong KF. Peripartum heart failure: idiopathic cardiomyopathy or compounding cardiovascular events? *Obstet Gynecol* 1986;67:157-68.
54. Demakis JG, Rahimtoola SH. Peripartum cardiomyopathy. *Circulation* 1971; 44:964-8.
55. Demakis JG, Rahimtoola SH, Sutton GC, Meadows WR, Szanto PB, Tobin JR, et al. Natural course of peripartum cardiomyopathy. *Circulation* 1971;44:1053-61.
56. Veille J. Peripartum cardiomyopathies: a review. *Am J Obstet Gynecol* 1984; 148:805-18.
57. Froelich CJ, Goodwin JS, Bankhurst AD, Williams RC Jr. Pregnancy, a temporary fetal graft of suppressor cells in autoimmune disease? *Am J Med* 1980;69:329-31.
58. Kovithavongs T, Dosseter JB. Suppressor cells in human pregnancy. *Transplant Proc* 1978;10:911-3.
59. Melvin KR, Richardson PJ, Olsen EGJ, Daly K, Jackson G. Peripartum cardiomyopathy due to myocarditis. *N Engl J Med* 1982;307:731-4.
60. Sainani GS, Dekate MP, Rao CP. Heart disease caused by coxsackie virus B infection. *Br Heart J* 1975;37:819-23.
61. Sanderson JE, Koech D, Iha D, Ojiambo HP. T-lymphocyte subsets in idiopathic dilated cardiomyopathy. *Am J Cardiol* 1985;55:755-8.
62. Seftel H, Susser M. Maternity and myocardial failure in African women. *Br Heart J* 1961;23:43-52.
63. Walsh JJ, Burch GE, Black WC, Ferrans VJ, Hibbs RG. Idiopathic myocardial failure of the puerperium (postpartal heart disease). *Circulation* 1965;32:19-31.
64. Johnson JB, Mir GH, Flores P, Mann M. Idiopathic heart disease associated with pregnancy and the puerperium. *Am Heart J* 1966;72:809-16.
65. Mason JW, Billingham ME, Ricci DR. Treatment of acute inflammatory myocarditis assisted by endomyocardial biopsy. *Am J Cardiol* 1980;45:1037-44.
66. Homans DC. Peripartum cardiomyopathy. *N Engl J Med* 1985;312:1432-7.
67. Hagley MT, Mankad SV. Peripartum cardiomyopathy. *J Am Med Assoc* 1991;265:160-3.
68. Sutton MS, Cole P, Plappert M, Saltzman D, Goldhaber S. Effects of subsequent pregnancy on left ventricular function in peripartum cardiomyopathy. *Am Heart J* 1991; 121:1776-8.
69. White P. Pregnancy complicating diabetes. *Am J Med* 1949;7:609-16.
70. Gast MJ, Rigg LA. Class H diabetes and pregnancy. *Obstet Gynecol* 1985; 66:5S-7S.
71. Hare JW. Diabetic neuropathy and coronary heart disease. In: Reece EA, Coustan DR, eds. *Diabetes mellitus in pregnancy*. New York: Churchill Livingstone, 1988:515-22.